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ABSTRACT

Using nationally representative data generated by the normal, day-to-day operation of schools, this research tested the major conclusions drawn from case studies focusing on principal effectiveness. On the basis of detailed information regarding individual student characteristics and achievements, detailed characteristics of teachers and their instructional choices and methods, and detailed information on the characteristics and behavior of principals, relevant changes in the educational process and in student outcomes were measured in relation to particular types of principal behavior. After the introduction, section 2 reviews the literature on the principal's role in student achievement. In section 3, a general contextual model for student achievement is presented, and the research methodology is described in detail, including the educational production function approach to the model and the specification of the variables for principal behavior and attributes. The empirical results are presented in section 4. The study concludes that principals directly affect student achievement through providing strong leadership and reducing conflicts among the participants in the educational process. References are included, along with an appendix listing variables used in the analysis. (TE)

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Principal Effectiveness: Using Nonexperimental Data to Assess the Findings of Case Studies

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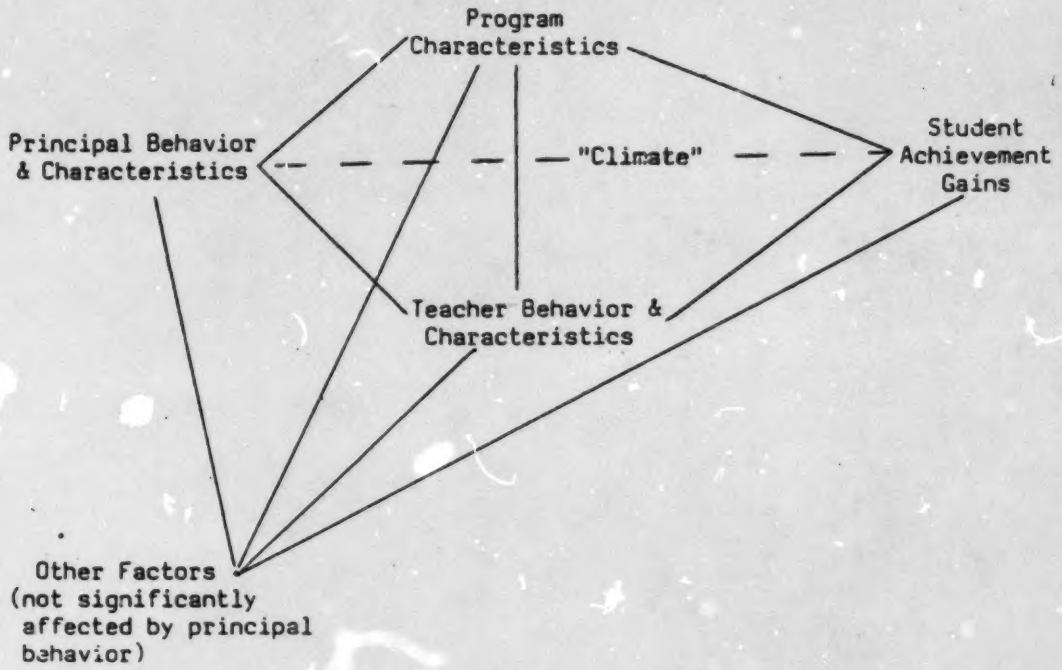
I. Introduction

The literature on effective schools and administrative leadership points to a variety of determinants of student achievement that can be influenced by various types of administrative behavior. The major studies from which such conclusions are drawn include Brookover et al. (1979). Rutter et al. (1979), Ayrault and Crosetto (1982), Edmonds (1979), Goodlad et al. (1979), Duke, Showers, and Imber (1980), Wellisch et al. (1978), Persell (1982), Greenfield (1982), and Gall (1983). Some of these studies are conveniently summarized by D'Amico (1982) and DeBevoise (1984).

Two major channels through which administrators affect student achievement are suggested by the literature: (1) through the design, coordination, implementation, and evaluation of instructional programs, and (2) through modification of teacher behavior. A third channel articulated by some researchers, although not as clearly defined as the previous two, is the general climate set by administrators in their interactions with teachers and students. Figure 1 provides a simple illustration of the three channels and other intervening factors.

Specific types of principal behavior identified with effective schools in these studies include: setting clear priorities and objectives that emphasize basic skill acquisition, assuming responsibility for evaluations of the achievement of these objectives, organizing and participating in staff development and inservice training programs, being a consistent, assertive disciplinarian, and working with teachers to achieve a

Figure 1 Channels Through Which Principals Affect Student Achievement Gains



consensus on objectives, methods, and staff development programs. While there is widespread agreement regarding these traits of principals, there is disagreement regarding whether principals should provide direct supervision of teachers on instructional matters.

Unfortunately, virtually all the conclusions regarding principal effectiveness are based upon individual case studies or limited data sets. Moreover, many of these studies examine only the determinants and process of student learning, rather than carrying the inquiry a step further to examine how these factors actually affect student achievement. Case studies (induced experiments) have many advantages in generating hypotheses, in evaluating the implementation of new techniques, and in providing detailed explanations and backgrounds for observed phenomena. A deficiency of case studies, however, is that their representativeness can rarely be demonstrated.

Using nationally representative data generated by the normal, day-to-day operations of schools, (i.e., data not obtained from special experiments), we tested the major conclusions drawn from case studies regarding principal effectiveness. We measured relevant changes in the educational process and in student outcomes attributable to particular types of principal behavior. Although secondary analysis of data has its own set of pitfalls, we believe the results of our research both extend and complement previous case studies. With detailed information regarding individual student characteristics and achievements (including pre- and post-test scores on standardized mathematics achievement tests), detailed characteristics of teachers and their instructional choices and methods, and detailed information on the characteristics and behavior of principals, we assessed under ceteris paribus conditions many of the standing conclusions regarding principal effectiveness.

In addition, the hierarchical nature of the data (e.g., student,

classroom, teacher, school, and district levels) provided opportunities to explore both the direct and indirect effects of principal behavior on student achievement. Thus, by being able to match students with teachers and teachers with principals, we were able to explore the various paths through which effective principal behavior is transmitted to students. Finally, by examining the effects of principal characteristics on students in over 300 schools nationwide, we assessed whether the findings obtained from previous studies hold true in larger samples.

The paper is organized as follows. In Section II we review in more detail the literature on the principal's role in student achievement. In Section III we offer a general contextual model for student achievement, discuss the educational production function approach to the model, and explain in detail the specification of the variables for principal behavior and attributes. In Section IV we present and discuss the empirical results. A final section provides a brief summary of our major conclusions.

II. Literature on Effective Principal Behavior

The literature on effective principal behavior addresses two broad issues: (1) do principals affect student achievement? and (2) if so, what elements of principal behavior are effective? A recent synthesis of the literature by DeBevoise (1984) and another by D'Amico (1982) offer good reviews of the literature. The review we present here is intended to identify a number of measures of principal behavior and to extract several hypotheses about principal effectiveness to be used in the analysis reported later in the paper.

Most of the studies that address the issue of effective principal behavior concentrate on the principal as instructional leader. For example, Wellisch and others, in evaluating the effect of various attributes of

administrators on student achievement, suggest that three characteristics of administrative behavior are important: how strongly administrators feel about instruction, whether they communicate their ideas concerning instruction, and the extent to which they assume responsibility for instruction (1978, p. 215). A number of studies, including Wellisch and others, have provided evidence that administrative leadership is indeed a promising area for research related to school improvement. Keeler and Andrews (1973), for example, find that the leadership behavior of principals, as perceived by their staffs, was significantly related to the productivity of schools. More recently, a number of other researchers have provided corroborating evidence in support of the hypothesis that school principal involvement in instructional leadership is correlated with improved student outcomes (Edmonds 1979, Brookover et al. 1979, and Wellisch and others, 1978). In addition, Wellisch and others contend that principals in schools where there had been student achievement gains were significantly more likely to "review and discuss teaching performance regularly with their staff" (p. 217). They also report that principals and teachers in these more successful schools were significantly more likely to report a high degree of program coordination.

Currently there is much debate about the potential of administrative leadership as a key to increase student achievement. While the studies noted above support the notion that principal involvement in instructional leadership will lead to school improvement, others have informed us that principals who actively engage in such activities are indeed rare (Deal 1975; Cohen and Miller 1980). Moreover, even researchers who accept the notion that instructional leadership is linked to school improvement have asserted that it is not the principal who is important per se, but rather that there are critical support functions that must be carried out. These support

functions may be performed by a variety of school personnel other than the principal including curriculum specialists, department heads, and teachers (Gersten and Carnine 1981). Finally, yet others caution that even when principals engage in the comprehensive set of tasks referred to as instructional leadership, the participation of teachers must also be considered as a critical variable (Wellisch and others, 1978). Unfortunately, Wellisch and others do not include a measure of the participation of teachers in their study of "School Management and Organization in Successful Schools."

Second, if administrative leadership is important to student achievement, what elements of administrative behavior are most important? Although an important role of the principal is to provide instructional leadership, very little of the principal's time is spent in any instructional interaction with students. The time the principal does spend with students is either related to disciplinary matters or to observing teachers in the classroom. The effect of principals on student achievement comes primarily through various interactions with teachers. The potential effect of this interaction can best be understood by considering what the ideal role of a principal should be. Edmonds, Cohen, Brookover, Gersten and Carnine, to mention a few, identify a number of ways in which the principal can enhance educational programs. These elements include 1) maintaining order, 2) acting as an agent of change, 3) setting clear objectives, 4) conveying high expectations for student achievement, 5) offering support and guidance to teachers, 6) providing public rewards and incentives, and 7) spending time in the classroom.

These activities have not yet been entered in any systematic way into educational production functions in order to estimate their effect on student outcomes. Fortunately, the data set used in this analysis has a number of

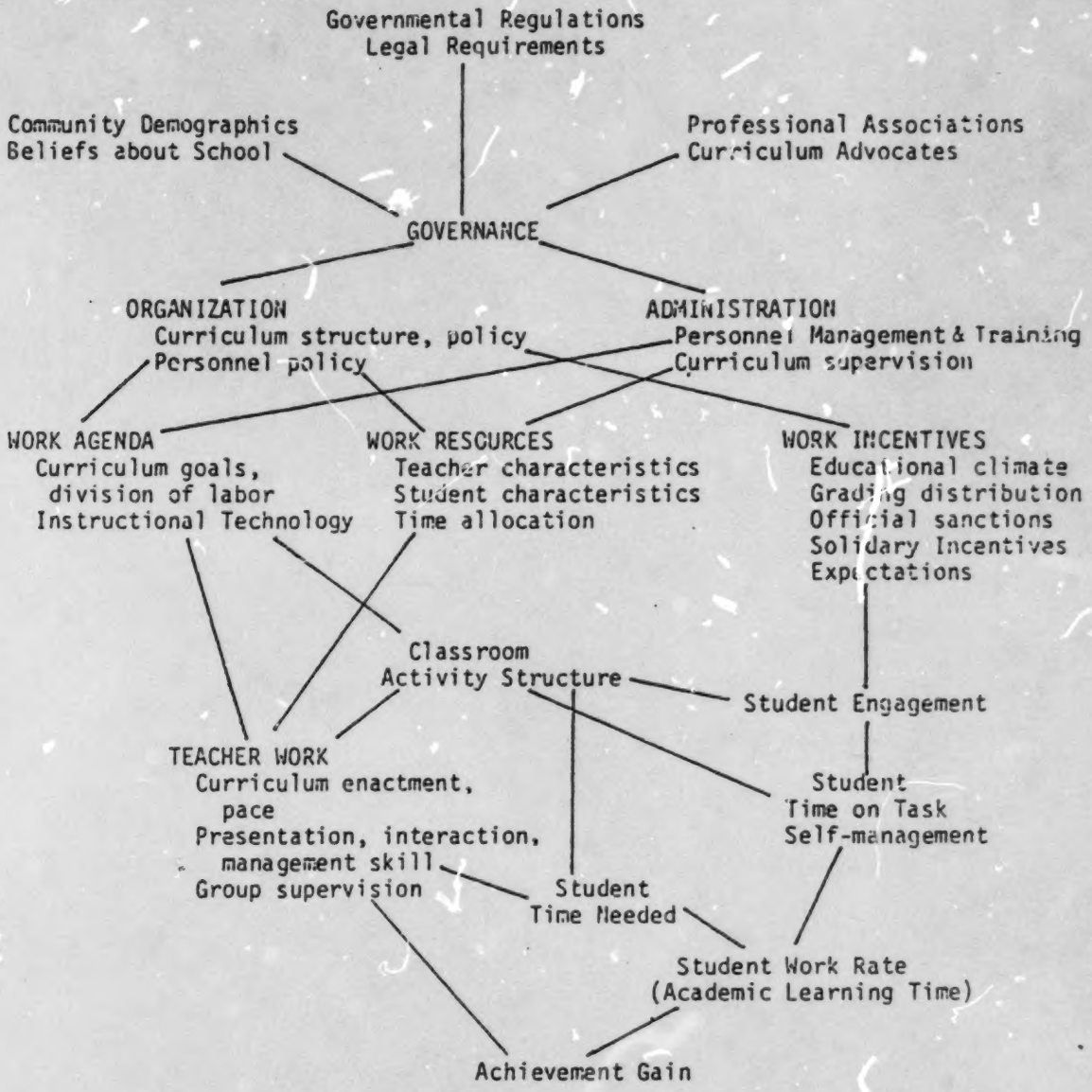
variables which relate to these attributes. The principal's instructional leadership can be captured in part by variables reflecting 1) the time principals spend in curriculum development, 2) the degree to which teachers sense their school has a coordinated curriculum, 3) the time principals spend related to needs assessment, problem planning, and program evaluation, 4) frequency with which the principal engages in classroom observation, 5) the degree to which teachers perceive that the principal is supportive of them, and 6) the degree to which teachers perceive the principal is supportive of innovative instructional practices.

III. Research Design and Methodology

The CEPM Research Paradigm of the determinants of student achievement gains, reproduced in Figure 2, provides a stylized summary of the way various researchers view the educational process. Our study focused on features of the educational process pertinent to administrative leadership. In particular, we examined the effect of principal behavior on achievement gains through the organization and implementation of instructional activities, through modifications of teacher characteristics and behavior, and through other changes in the school climate.

In previous work (Eberts and Stone 1984), we looked at the effect of work characteristics on teacher activities, including teacher time allocation and student time on task. In turn, we linked these activities directly to student achievement gains. In relation to Figure 2, we have looked at the relationships outlined from work characteristics (e.g., work agenda, work resources, and work incentives) down to student achievement. Among the most important determinates of student achievement gains explored in the previous study was the time teachers spend in instruction and preparation.

Figure 2 CEPM Research Paradigm



Source: Duckworth, K., Linking Educational Policy and Management with Student Achievement, Center for Educational Policy and Management (CEPM), 1980.

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To focus on the channels through which principals affect student achievement, as previously outlined, models of the educational process must be specified and tested in greater detail, capturing more subtle features of the process related to principal effectiveness. Thus, with substantial work already completed analyzing the factors outlined in the lower half of Figure 2, we now turn to some of the most prominent hypotheses regarding factors one level higher (Administration and Organization) related to principal behavior, and to how these are transmitted to student achievement. This ambitious task was moderated substantially by the fact that we focused on a limited number of hypotheses, those suggested by previous research as most dominant. In the remainder of this section, we first consider the education production function methodology we employed. Next, we describe the data used in our empirical tests and describe in some detail the variables used (especially, those related to principal effectiveness). Finally, we explain how the variables for principal behavior and effectiveness were entered into the educational production function.

Educational Production Functions

Education is a service that takes students, with whatever attributes they bring to the classroom, and transforms them into humans with different qualities. Educational production functions relate differences in the quality of students to differences in school resources they received. Educational production functions, therefore, are a convenient vehicle for exploring the channels through which principals may affect student achievement. Although, specifications of educational production functions differ among studies, most models share the features described by equation (1), which is borrowed from Hanushek (1979):

$$(1)\quad A_{it} = f(B_{it}, P_{it}, S_{it}, I_i)$$

where

A_{it} = student outcomes of ith students at time t,

B_{it} = vector of family background influences of ith student cumulative to time t,

P_{it} = vector of influence of peers of ith student cumulative to time t,

S_{it} = vector of school inputs of ith student cumulative to time t, and I_i = vector of innate abilities of ith student.

The model incorporates a number of essential aspects of the educational process. First, inputs are those that are relevant to the individual student. Second, the inputs are cumulative which reflects the fact that schooling and other experiences in past years have a bearing on student outcomes in the present period. Third, school inputs include purchased (e.g., teachers) as well as non-purchased inputs (e.g., peer groups). Fourth, the allocation of resources is predetermined from the perspective of the production function.

A somewhat popular variant of the model and one which requires substantially less data collection, is the value added model. Instead of considering the contribution of past inputs on student outcomes, this specification considers the changes in student outcomes between two time periods, usually the beginning and end of a particular school year. This formulation reduces the data requirements since inputs are only collected over the same two year period, not over an extended period of time. The value added model results from simply subtracting equation (1) for period t^* from equation (1) for period t, thru yielding

$$(2)\quad A_{it} = f^*[B_i(t-t^*), P_i(t-t^*), S_i(t-t^*), I_i, A_{it}^*]$$

Student outcomes in the earlier period (A_{it}^*) may be considered

pretests taken by students at the beginning of the school year. These scores are then compared with scores of tests taken at the end of the school year. In this way, the gains in student outcomes attributed to a flow of educational services within a given time period can be assessed. Variables such as teacher time and student time on task are used to capture the flow of resources.

In most of the studies considered under the rubric of educational production functions, standardized test scores of cognitive skills are used as the measure of student outcomes. Test scores are obviously not intended to measure all the attributes of education. School outcomes encompass, in addition to the acquisition of skills, conveyance of social norms, development of creative skills, and the provision of custodial services.

A few studies have considered student attributes other than test scores as dependent variables. For example, Levin (1970), and Boardman, Davis, and Sanday (1977) considered student attitudes; Katzman (1971) looked at attendance rates; and Katzman (1971) and Burkhead, Fox, and Holland (1967) used college continuation and dropout rates. These are all sensible measures. The decision of the vast majority of studies to use cognitive test scores results from a combination of availability and a certain conceptualization of education. Most school districts administer some form of standardized tests. Even though there is considerable controversy over what these tests actually measure, educators tend to believe that they are important. Performance on tests is used to advance students through the educational system, evaluate programs, and even to allocate funds. Further, it appears, given the recent concern over declining SAT scores, that interest in test scores is increasing.

Data

Nonexperimental data provide a snapshot of the workings of school systems. Thus, analysis of those data can be used to show how all the various educational resources, institutional policies, and behavioral responses of teachers, principals, and students come to bear on the achievement gains of students. Consequently, this approach to assessing the effectiveness of principals requires a substantial data base in order to capture many of the important mechanisms at work in schools. Basically, three groups of data are required. First, information is needed regarding the educational process. This would include relevant student demographics, teacher characteristics and tasks performed, and classroom organization. Second, information is required about principals. In particular, we need to know their characteristics, their involvement in leadership activities, and how they interact with teachers and students. Third, variables reflecting the institutional structure of the school and district are important to behavioral responses of teachers, students, and principals to these policies.

Fortunately, the data needed to undertake our study had already been compiled from a study sponsored in the mid-1970s by the Office of Education and conducted by the Systems Development Corporation (SDC). They amassed data from over 100,000 students in grades three through six in over 300 districts selected to be representative of schools across the country. They followed the same group of students for three years and recorded the amount of resources each student received at the classroom level, school level, and district level. They gathered student background information, teacher and principal characteristics, and detailed information about school and district decision-making processes.

Two general types of data were gathered regarding principal

instructional leadership. The first set of data records the amount of time principals spend in activities related to math curriculum development and to assessing needs, planning instructional programs, and evaluating these programs. The second set of data reflects teachers' and principals' assessments of the effectiveness of certain leadership activities and how well the staff works together. Teachers and principals were asked, for example, if they strongly agree, agree, disagree, or strongly disagree with the following questions:

1. School programs are well planned and clear;
2. Principal provides active leadership to math and reading programs;
3. Teachers in this school work well together;
4. Administrators keep teachers well-informed;
5. Conflicts among individuals are identified and faced, and not allowed to fester.

By recording responses to these questions from both teachers and administrators, it is possible to check whether an individual's own assessment of his or her actions is more effective than another person's assessment. A more detailed description of the SDC data is attached as Appendix A.

Specification of Principal Behavior and Effectiveness

The variables describing principal characteristics and activities were entered into the educational production function in two ways. First, those variables that relate to the direct effects of administrative behavior or to indirect effects that are not explicitly specified (e.g., teacher's assessment of certain leadership activities and characteristics) were entered directly into the educational production function. Second, those principal attributes and behaviors that affect student achievement indirectly through

their effect on teacher behavior were used to explain differences across classrooms in teacher activities and classroom structure.

For the direct principal effects and those indirect effects that were unobserved, we constructed four variables in addition to such principal attributes as highest degree, experience in teaching, and experience in administration. In each case we were able to construct measures that reflected the joint perceptions of teachers and principals, as well as the degree to which the teachers' and principals' perceptions differ.

The four variables are LEAD, INSTR, CONFL and FACE. The LEAD represents the average perception of both teachers and the principal of whether the principal exhibits "active leadership." The perceptions were joint in the sense that principal responses were averaged and then transformed into unit-normal variates. The second variable, INSTR, is the joint perception of the principal's involvement in the math curriculum and whether he is an active participant in teacher inservice programs. CONFL is a composite variable reflecting the joint perceptions of whether teachers are satisfied with the principals decisions and whether the principal is effective in identifying conflicts. FACE reflects perceptions of whether the principal and teachers work well together. All four variables have been suggested in the literature as areas where principals can affect student achievement.

Perceptions do not always coincide, however. Thus we included for each of the four variables above a corresponding variable that reflects the degree of disagreement between teachers and the principal in each area. To construct each of these we subtracted the teacher's perception from the principal's and multiplied the difference by the absolute value of the difference. This is akin to squaring the difference, except that the sign is retained. Larger differences are, therefore, assigned to more than

proportionate effects. Divergences of opinion, where the principal perceives the situation more favorably than teachers, will be associated with less effective schooling and lower student achievement. Constructing the variables in this way follows from the understanding that principal effectiveness is transmitted to students through teachers since principals spend relatively little time in contact with students. Consequently, teachers' perceptions of the performance of principals and thus the divergence of opinion of teachers and principals about the principal's performance are expected to influence student achievement in the direction specified. The names of these "agreement" variables are ALEAD, AINSTR, ACONFL, and AFACE, respectively.

We were also interested in whether other principal attributes are important. To pursue this issue we included in the analysis the highest degree held by the principal, the principal's experience in teaching, and the principal's experience in administration. All were hypothesized to enter with positive signs.

To explore the indirect effects of principals on student achievement in detail we considered the influence of the principal variables above on more proximate determinants of achievement. We were particularly interested in whether principals are able to affect such things as teacher time in instruction, teacher time in preparation, teacher time in administration, and math in-service programs. To do this we examined each of these separately at the teacher or classroom level.

Specification of Other Control Variables

In addition to the variables that were of central interest, we also included a number of control variables for various background characteristics of students, teachers, and schools. For the student-level data these

included the sex of the student, race, the pretest score (and the pretest score squared, to account for nonlinearities), student socioeconomic status, school climate, the teacher's highest degree, the teacher's experience, the number of math courses taken by the teacher since the degree, various staffing ratios (administrators per student and clerical workers per student), the school's average daily attendance, and whether the teachers are covered by a collective bargaining agreement. We had little direct interest in these variables, hence offer little discussion or interpretation of their empirical results here, but those who are interested may refer to chapter three of Eberts and Stone (1984).

IV. Empirical Results

Direct and Unobserved Indirect Effects

The means and standard deviations of the variables are displayed in Table 1. The student-level estimates used to test our hypotheses regarding the direct and unobserved indirect effects of principals on student achievement gains are presented in Table 2 and summarized in Table 5. The coefficient for two of the four variables regarding perceptions of the principal's behavior (INSTR and CONFL) are significantly positive at the 0.05 level, indicating that instructional leadership and conflict resolution are effective principal traits. The coefficients for perceptions of how well the teachers and principal work together (FACE) is not significantly related to student achievement, and the coefficient for perceptions of the principal as an active leader (aside from instruction and conflict resolution) is negative (significantly so at the 0.05 level). The coefficients for principal attributes of teaching experience and administrative experience are both significantly positive at the 0.05 level, but the coefficient for the principal's highest degree is significantly negative, perhaps indicating that

such principals are assigned to more difficult schools. The negative relationship between degree level and student achievement is also found for teachers in this and many others studies. Murnane (1981) interprets this finding to reflect the propensity of school personnel to obtain additional education and as a way to advance along the salary schedule than as a way to improve teaching skills.

The perception disagreement variables did not generally enter significantly. The coefficient for ACONFL, however, was significantly negative as expected. This coefficient, taken along with the significantly positive coefficient for CONFL, suggested that the conflict resolution role of the principal, and perceptions of the principal's performance in this role, are a preeminent part of effective principal behavior. Moreover, active leadership in noninstructional areas (or areas of little conflict) and working well together in areas of little conflict appear to be unrelated to student performance.

The background control variables generally entered as expected, with teacher's highest degree and math inservice programs important exceptions. The previous sign for teacher's highest degree has already been discussed. The perverse sign for the coefficient for math inservice programs probably indicates that such programs "signal" difficulties with student math performance.

Indirect Effects

The teacher or classroom level estimates used to test our hypotheses regarding the indirect effects of principals on teacher time in instruction, in preparation, in administration, and on math in-service programs are presented in Table 4 and summarized in Table 5. Again, for each equation we regress the teacher time variable on the principal variables and attributes,

as well as on other background control variables. All these variables, of course, are now at the teacher or classroom level.

The results for teacher time in instruction revealed only one significant coefficient for the principal variables, that for differences in perceptions regarding conflict identification and resolution (ACONFL). This coefficient entered significantly negative as predicted and again underscores the importance of this principal role.

The results for teacher time in preparation revealed two significant coefficients with the predicted signs--those for LEAD and CONFL. Both enter significantly with positive signs. The coefficient for FACE, perceptions of how well the teachers and principal work together, was significantly negative, counter to predictions. (One could speculate that principal-teacher cooperation reduces the importance of additional preparation time.) None of the remaining principal variables entered significantly at the 0.05 level.

Not surprisingly, perhaps, teacher time in administration is invariant with respect to any of the principal variables. None of these estimates were significant. The results of math in-service programs, however, were strikingly different. The coefficients for both INSTR and CONFL, the perceptions of instructional leadership and conflict resolution, were significantly positive. In addition, the coefficent for ACONFL, the variable for the difference in perceptions of conflict resolution, was significantly negative. This again suggests the importance of this role for effective principals.

In summary, we generally found for both the direct, unobserved indirect, and indirect paths that instructional leadership and conflict resolution are important roles for effective principals, and that divergence of opinion regarding the resolution of conflicts is associated with less effective schools. Thus, the results are generally supportive of the central

thrust of previous findings from case studies. We did find, however, that controlling for instructional leadership and conflict resolution, active leadership, and working well together in other areas are not associated with effective schools or student achievement. The latter may be an affirmation of T. Sizer's (See DeBevoise 1984, p. 17) speculation that a "strong principal" does not necessarily make an effective school.

V. Caveats and Conclusions

One aspect of the analysis that needs to be addressed is the contribution of principals on student achievement. As mentioned earlier, seven out of the eleven variables included in the student achievement equation were statistically significantly different from zero. This indicates that the variables have significant independent effects on student test scores. However, when one considers the percentage of the variation in student test scores explained by the principal variables, the magnitude is very small, only 0.4 percent. At first, it may seem as if the effect of principal variables are too trivial to be worth discussing. But given the nature of the analysis, this is not necessarily so. It must be recognized that the student achievement model is capturing the effect of principals during one school year, which is a very short time period considering the student is in school for at least twelve years.

The cumulative nature of the process is clearly evident by comparing the R-squared of the student achievement model when the pretest score is included and when it is omitted. When the pretest score is removed the percentage of the variation in student test scores explained by the remaining variables drops from 55 percent to 25 percent. Obviously, the pretest score, which captures the effect of schooling and other influences in previous years, explains a large proportion of the variation in student test scores.

Viewed in this context, the magnitude of the principal variables is no less significant than many of the teacher-related variables. In fact, comparing the standardized beta coefficients (not reported here) of the student achievement model, the principal variable, the time principals spend assessing the math program, has the largest single effect on student achievement of all the school-based impact, including teacher time in instruction.

The relatively small explanatory power of the school-based inputs included in the student achievement equation is in many respects reassuring, particularly when compared to other research conducted in this area. If principals (and teachers) have a much larger effect on student achievement than estimated here, we would expect to find tremendously significant effects recorded in multivariate-type analyses as well as case studies. If such large effects actually existed, then there should be no debate on what makes for an effective principal (or teacher); the prescription would be clear from any properly performed analysis.

Instead of uncovering strong relationships between principals and student achievement, researchers have uncovered at best only subtle characteristics that distinguish a principal who is effective from one who is not effective. Indeed, our analysis does no more and no less than previous studies on principal effectiveness, with one exception. Taking the hypotheses that have been set forth from case studies which have examined a few principals in a handful of schools, we extended the analysis to test these hypotheses for a representative sample of students and principals across the country. We found that principals do make a difference in student achievement, but, like the findings of previous studies, the attributes that are effective are subtle, with a relatively small impact recorded over a single year.

Our conclusion, therefore, closely parallels the conclusion drawn in a recent synthesis of the research on Principal Leadership:

> Ultimately the provision of instructional leadership can be viewed as a responsibility that is shared by a community of people both within and outside the school. Principals initiate, encourage, and facilitate the accomplishment of instructional improvement according to their own abilities, styles, and contextual circumstances. They still need a lot of help from others if improvement is to become norm." (DeBevoise 1984, Educational Leadership, p. 20).

We might add that principals appear to be equal partners with teachers in their contribution to student achievement. Principals directly affect students through providing strong leadership and reducing conflicts among the participants in the educational process.

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Table 1: Means of Variables at the Student Level

Variable Name	Variable Definition	Mean	Standard Deviation
LEAD	Active Principal Leadership	.001	.733
INSTR	Instructional Leadership	.002	.654
CONFL	Conflict identified	-.002	.594
FACE	Work well together	-.013	1.534
ALEAD	absolute value of LEAD	.070	3.135
AINSTR	absolute value of INSTR	.198	2.972
ACONFL	Absolute value of CONFL	-.001	2.975
AFACE	Absolute value of FACE	.030	3.393
PDEGREE	Highest degree of Principal	2.997	.214
PRINEXP	Experience teaching of Principal	10.189	5.355
PEXPAD	Experience in administration	15.078	7.541
SEX	Female equals one	.514	.582
RACE	white equals one	.731	.108
SBC034	Childhood Experience	1.061	1.160
SBC035	Total parental involvement	1.879	1.683
SBC037	Economic status	224.774	89.547
PRE	Pretest score	29.836	35.531
PRESQ	Pretest score squared	2152.646	35137.926
ADSTUD	Administrators/student ratio	.004	.001
OFFSTUD	Clerical/student ratio	.019	.013
TTINSTR	Teacher's time in instruction	4.886	.766
TTPREP	Teacher's time in preparation	1.404	.725
TTADMIN	Teacher's time in administration	.790	.627
TQA001	Years teaching of teacher	11.981	7.840
TQA004	Highest degree of teacher	2.465	.518
TQA006	Math courses taken by teacher	.610	1.078
TQA012	Math inservice	7.368	14.047
SCHADA	School enrollment	553.232	296.162
UNION	Union equals one	.636	.481
POST	Post test score	38.894	13.005

Source: "Sustaining Effects Study" conducted by the Systems Development Corporation, Santa Monica, CA.

Table 2: Estimates of an Educational Production Function with Principal Variables

Variable Name	Variable Definition	Estimate	T-ratio
Intercept		6.721	4.67
LEAD	Active Principal Leadership	-.216	1.96
INSTR	Instructional Leadership	.247	2.20
CONFL	Conflict identified	.548	3.14
FACE	Work well together	-.082	1.30
ALEAD	abeolute value of LEAD	-.034	1.37
AINSTR	abeolute value of INSTR	.009	.35
ACONFL	Abeolute value of CONFL	-.057	1.97
AFACE	Abeolute value of FACE	.016	.64
PDEGREE	Highest degree of Principal	-.922	2.69
PRINEXP	Experience teaching of Principal	.055	4.01
PEXPAD	Experience in administration	.066	6.67
SEX	Female equals one	-1.486	11.73
RACE	White equals one	5.065	6.71
SBC034	Childhood Experience	.003	.04
SBC035	Total parental involvement	.085	1.90
SBC037	Economic status	.015	16.27
PRE	Pretest score	.932	108.03
PRESQ	Pretest score squared	-.0009	105.26
ADSTUD	Administrators/student ratio	-74.27	1.68
OFFSTUD	Clerical/student ratio	-6.318	1.09
TTINSTR	Teacher's time in instruction	.580	5.81
TTPREP	Teacher's time in preparation	.293	2.77
TTADMIN	Teacher's time in administration	-.203	1.67
TQA001	Years teaching of teacher	.011	1.14
TQA004	Highest degree of teacher	-.715	4.87
TQA006	Math courses taken by teacher	.063	.91
TQA012	Math inservice	-.022	4.16
SCHADA	School enrollment	-.0006	2.20
UNION	Union equals one	.627	3.98
Dependent Variable: Post Test Score			
R-squared		.55	
No. of Observations		14,959	

Table 3: Means of Variables at the School Level

Variable Name	Variable Definition	Mean	Standard Deviation
LEAD	Active Principal Leadership	-.051	.707
INSTR	Instructional Leadership	-.025	.600
CONFL	Conflict identified	.006	.519
FACE	Work well together	.090	1.414
ALEAD	absolute value of LEAD	-.174	2.929
AINSTR	absolute value of INSTR	-.170	2.669
ACONFL	Absolute value of CONFL	-.208	2.769
AFACE	Absolute value of FACE	.001	3.237
PDEGREE	Highest degree of Principal	2.968	.270
PRINEXP	Experience teaching of Principal	10.473	5.629
PEXPAD	Experience in administration	14.814	7.787
SEX	Female equals one	.514	.106
RACE	White equals one	.738	.085
SBC034	Childhood Experience	1.037	.392
SBC035	Total parental involvement	1.939	.966
SBC037	Economic status	223.735	59.426
PRE	Pretest score	29.895	6.421
PRESQ	Pretest score squared	1842.523	4822.156
ADSTUD	Administrators/student ratio	.004	.003
OFFSTUD	Clerical/student ratio	.019	.012
TTINSTR	Teacher's time in instruction	4.962	.604
TTPREP	Teacher's time in preparation	1.417	.567
TTADMIN	Teacher's time in administration	.758	.459
TQA001	Years teaching of teacher	12.422	6.447
TQA004	Highest degree of teacher	2.452	.424
TQA006	Math courses taken by teacher	.588	.817
TQA012	Math in-service	6.426	9.470
SCHADA	School enrollment	433.343	261.783
UNION	Union equals one	.649	.478
POST	Post test score	39.537	6.440

Source: "Sustaining Effects Study" conducted by the Systems Development Corporation, Santa Monica, CA.

Table 4: Estimates of the Effect of Principal Variables on Teacher Activities

Explanatory Variable	Dependent Variable: Time Teachers spend in: Instruction	Preparation	Administration	Inservice
INTERCEPT	5.287**	.852	.406	7.423
LEAD	-.099	.088	.047	.568
INSTR	-1.074*	.008	.060	1.726
CONFL	.039	.134	-.008	3.248**
FACE	.006	-.017	-.014	-.079
ALEAD	.016	-.003	-.006	.009
AINSTR	.013	.001	-.011	-.164
ACONFL	-.034**	-.009	.003	-.381
AFACE	.020	-.022*	-.0001	-.019
PQA001	-.123	-.063	-.079	1.758
PQA002	-.005	-.017**	.004	.013
PEXPAD	-.006	-.000	.006*	-.008
SEX	.462	.404	-.502*	-1.925
RACE	.042	-.277	.346	-3.537
SBC034	-.169*	-.042	.033	-.965
SBC037	.002*	-.0001	.0009	.003
PRE	-.004	.008	-.002	-.198
PRESQ	-.00001	-.00001	-.00001	.0003
ADSTUD	18.247	-.750	-12.154	-109.220
OFFSTUD	-5.500	3.701	5.464**	52.702
TQA001	.012**	.009*	.007	.031
TQA004	-.043	.267**	.048	.576
TQA006	.066	-.036	.020	.002
SCHADA	-.0001	-.0001	.0001	.002
UNION	-.235**	.050	.020	-1.102
R-squared	.19	.12	.11	.09
No. of observations	285	285	285	285

Note: (*) denotes significance at the 10 percent level: (**) denotes significance at the 5 percent level. See description of variables in Table 3.

Table 5: Summary of Results

(A) Direct & Unmeasured Indirect Principal Effects on POST
(Table 2)

VAR	LEAD +	INSTR +	CONFL +	FACE +	ALEAD -	AINSTR -	ACONFL -	AFACE -
SIGN	-	+	+				-	

VAR	PQA001 (Ed) +	PQA002 (T Exp) +	PEXPAD (Ad Exp) +
SIGN	-	+	+

(B) Principal Effects on Determinants of POST
(Table 4)

Explanatory Variable

Dependent Variable	LEAD +	INSTR +	CONFL +	FACE +	ALEAD -	AINSTR -	ACONFL -	AFACE -	PQA001 +	PQA002 +	PEXPAD +
Parental Involvement				+							
TTINSTR							-				
TTPREP								-			
TTADMIN reverse signs											
TQA012 inservice		+	+				-10%				

*NOTE: 11 signs tested at .05 level, except where otherwise indicated. The signs next to the variable name denote the hypothesized direction of the effect. The signs in the box direct the estimated direction of the effect. If no sign is displayed, then the estimate was not significantly different from zero.

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Appendix A

Variables Used in Analysis

Appendix A: Variables Used in Multivariate Regression Analysis of Growth in Student Achievement on Math and Reading Tests
(Source: Sustaining Effects Study)

A. STUDENT VARIABLES

1) Age

2) Sex

3) Race

4) Economic status: Percentage of the Orshandky Poverty Index, range 46-427.

5) Childhood experience: The exposure of the student to either kindergarten, headstart, summer school, nursery/day care, or preschool, range 0-1.

6) Parent involvement: Participation of the student's parent(s) in any school activity: positive or negative, related or unrelated to the student, range 0-12.

7) Exact grade level: An index of student grade and entrance time, range 1.1-6.5

B. ACHIEVEMENT MEASURES

1) Achievement growth: The difference between fall at-level and spring below-level Comprehensive Test of Basic Skills for Mathematics (and Reading).

2) Pretest: The fall at-level Comprehensive Test of Basic Skills for Mathematics (and Reading).

NOTE: The achievement tests were published by McGraw-Hill and copyrighted in 1973.

C. TEACHER CHARACTERISTICS

1) Experience: Number of years teaching inside and outside the district

2) Highest degree: 1 = no degree or degree based on fewer than 4 years of school
2 = bachelor's degree
3 = master's, bachelor's + fifth year preparation, or sixth year specialist's degree
4 = doctor's degree, range 1-4

3) Course in Math (and reading): Amount of college-level courses in math (reading) the teacher has taken, range 0-6.

4) Math (reading) inservice: Hours of inservice the teacher has experienced in the last three years, range 0-81.

5) Mode of instruction

a) individualized approach: A composite of the individualized instructional approach of the teacher. The composite is based on uses of subgroups, the sameness of time for activities, learning sequences, instructional activities, expected rate of progress, instructional methods, math content for regular and low-achieving students.

b) class organizations: Teachers were asked to indicate which of the following practices are used extensively in their school:

i) mixing students of different ability levels in classes
ii) assigning students to classes on the basis of ability
iii) use of ungraded classes
iv) flexible scheduling of classes
v) mixing grades within classes

6) Contract salary: What is your expected contract salary for teaching in this school system this year? Do not include supplements for extra services (Mark one):

Less than $4,000	$16,000-18,999
$4,000-6,999	$19,000-21,999
$7,000-9,999	$22,000-24,999
$10,000-12,999	$25,000 or more
$13,000-15,999	

7) Time allocation: Teachers were asked to answer the following two questions:

In a typical day, how much time do you devote to instructing students? Omit recess, lunch, etc. (Mark one.)

2 hours or less	3 hours	4 hours	5 hours	6 hours or less

In a typical day, about how much time do you devote to non-instructional activities? (Mark the number of hours in each category. Include both time at school and time after school.)

None	Preparation for instruction	Administrative and clerical tasks	Interactions with individual parents	Other school-related non-instructional activities
1/2 hour or less				
1 hour				
1-1/2 hours				
2 hours				
2-1/2 hours				
3 or more hours				

8) Attitudes:

a) Educational philosophy

In your opinion how important is each of the following factors in explaining student academic performance? (Mark one column for each factor.)

	The most important	Among the more important	Among the less important	The least important
Income level of family				
Home environment				
Ability level of student				
Student motivation				
Adequacy of instructional materials				
Quality of instruction provided				

b) Instructional technique: Teachers were asked to answer the following questions:

Which of the following statements most nearly describes your own approach to the use of rewards in the classroom? (Mark one.)

I try to offer recognition to students primarily when they achieve specific objectives. I use praise or other rewards mainly to help students acquire specific academic skills and social behaviors.

I try to establish a warm accepting climate for all students, giving them praise, affection, and other rewards no matter how well they achieve, or, within limits, what they do.

About how frequently, do you use each of the following techniques to handle disruptive classroom behavior? (Mark one column for each procedure.)

	Several times a week	Several times a month	About once a month	Very infrequently	Never
Isolate the student in the classroom					
Send student to alternate room					

Provide alternate activity
Change student's seat
Send student to higher authority

c) General attitudes concerning school

How satisfied are you with the way most decisions are made in your school? (Mark one.)

Very Satisfied Somewhat Satisfied Not Satisfied at All

For each of the statements below concerning this school, indicate your general feelings. (Mark one column for each statement.)

	Strongly agree	Agree	Disagree	Strongly disagree
The school's program are well planned and clear				
The school's programs are successful in meeting students' needs				
Teachers in this school conduct effective instruction				
Teachers in this school work well together				
This school is a satisfying place in which to work				
Staff development training provided me is adequate				
I have sufficient resources to carry out effective instruction				
Conflicts among individuals are identified and faced, and not allowed to fester				

d) Teacher assessment of administrative leadership: Response of teachers to various questions:

Which phrase best describes your principal's (or other members of the administrative staff) support of your work as a teacher? (Mark one.)

Very supportive
Somewhat supportive
Neutral
Somewhat unsupportive
Very unsupportive

Which of the following statements best characterizes your principal's role with respect to your school's instructional programs? (Mark one.)

The principal has a distinct point of view, and actively promotes it.

The principal has a point of view, but lets teachers

do as they think best.

Does the principal of your school encourage teachers to try our new teaching method? (Mark one.)

Yes, the principal openly encourages innovation.

Yes, but only under close supervision.

No, the principal prefers proven methods.

The principal neither encourages nor discourages innovation.

For each of the statements below concerning this school, indicate your general feelings:

	Strongly agree	Agree	Disagree	Strongly disagree
The principal provides active leadership to reading and mathematics programs				
Administrators keep teachers well informed				

D. PRINCIPAL VARIABLES

1) Personal Characteristics (Same Variables as Teachers)

2) Instructional Leadership Variables

a) About how frequently do you or your assistant observe classroom instruction for regular and low-achieving students for a period of 10 minutes or more? (Mark one in each column.)

	Regular Students	Low-Achieving Students
a. Do not observe or do not have this type of student	_____	_____
b. Once a semester	_____	_____
c. Once a month	_____	_____
d. Once a week	_____	_____
e. More than once a week	_____	_____
f. Daily	_____	_____

3) Amount of staff development training

For the following areas, indicate how much staff development training (sponsored by the school, district, region, or state) you have received within the last three years. Include only formal courses or workshops. (Mark one column for each area.)

	None	1-3 hours	4-6 hours	7-10 hours	More than 10 hours	Only training was more than 3 years ago
a. Curriculum and instruction for low-achieving students	___	___	___	___	___	___
b. Leadership techniques	___	___	___	___	___	___
c. School-community relations	___	___	___	___	___	___
d. Needs assessment procedures	___	___	___	___	___	___
e. Program planning procedures	___	___	___	___	___	___
f. Program monitoring and evaluation procedures	___	___	___	___	___	___

b) Time principals spend on certain activities related to administrative leadership

How much time have you spent during this school year by participating in activities related to curriculum development in your school (e.g., attending workshops, attending local school meetings on curriculum development, etc.) in the areas listed below? (Mark one in each column.)

	Reading	Math
a. None		
b. 1-5 hours this year	___	___
c. 6-10 hours this year	___	___
d. 11-15 hours this year	___	___
e. 16-20 hours this eyar	___	___
f. More than 20 hours this year	___	___

4) Principal's attitude toward:

a) Education

Which of these statements comes closest to expressing your philosophy? (Mark one.)

a. ____ Most children learn best when lessons are specific, presented to the child in small steps, and with a well-planned sequence worked out in advance. With this in mind, teachers should carefully structure the lessons and experiences of their students.

b. ____ Most children learn best by discovering things for themselves. Too much structure hinders their natural desire to discover, learn, and explore. Teachers should help students, not give them pre-digested materials.

To what extent do you believe the following are effective in raising the achievement of low-achieving students? (Mark one column for each group.)

	Effective	Moderately effective	Generally ineffective
a. Retraining teachers to teach low-achieving students	____	____	____
b. Mixing students of different achievement levels in classes	____	____	____
c. Having small classes (10 or fewer students)	____	____	____
d. Increasing the number of remedial reading and math support personnel	____	____	____
e. Increasing numbers of counseling and psycho-therapy personnel	____	____	____
f. Staring remedial education at the preschool level	____	____	____
g. Extensive use of cross-age tutoring	____	____	____
h. Parent involvement in classroom activities	____	____	____

b) Importance of teacher participation

In which of the areas listed below is teacher participation very

important, important, or unimportant? (Mark one column for each decision area.)

	Very Important	Important	Unimportant
a. Assignment of students to classes	___	___	___
b. Development of student grading procedures	___	___	___
c. Assignment of teachers to classes	___	___	___
d. Selection of basic instructional materials	___	___	___
e. Planning of course content	___	___	___
f. Promotion of school/ community interaction	___	___	___

c) Principal's assessment of own leadership (same as teacher's assessment)

E. DISTRICT CHARACTERISTICS

NOTE: These characteristics were reported by the district superintendent or a designated member of his/her staff

1) Student enrollment K-12 on or about October 1 by school

2) Staff personnel

a) official administrative

i) district administrators
ii) building administrators

b) professional

curriculum specialist
counselor
library/media personnel
teacher
psychologist, therapist, etc.
community relations personnel
social worker
other

c) technical, office, clerical

student teacher/teaching assistant/teaching intern
teaching aide
office/clerical
other

3) School climate and extent of physical violence: A composite measure was constructed by indexing the responses to the following questions:

Compared to other schools with which you are familiar, is there much vandalism in this school and on the school ground? (Mark one.)

a. ____ A great deal of vandalism

b. ____ An average amount of vandalism

c. ____ Less vandalism than in other schools

d. ____ No vandalism at this school

Compared to other schools with which you are familiar, is there much physical violence in this school (.e.g, fights among students, attacks on teachers, etc.)? (Mark one.)

a. ____ More than in other schools

b. ____ About the same as in other schools

c. ____ Less than in other schools

d. ____ No violence in this school

4) Collective Bargaining

a) Teachers covered by a collective bargaining agreement: teachers were considered to be covered by a collective bargaining agreement if the superintendent answered affirmatively to the following question

Are elementary school teachers in your district covered by a master contract which was bargained by an organization recognized as the bargaining agent for the teachers?

b) Characteristics of the contract

Which of the following are covered in your master contract with the organization recognized as the bargaining unit for the teachers?

____ Teacher participation in selection of classroom materials.

____ Preparation time during normal school hours for elementary teachers

____ Teachers participation in budgeting

____ Teachers participation in program planning and evaluation

____ Staffing and class size

____ We do have a contract, but it does not cover these issues

Construction of Variables Used in Estimation

(A) Direct and Unmeasured Indirect Principal Effects on Post

(1) Joint Perceptions

LEAD = (PQA051 + TQA080)/2;

active leadership (P) (T)

INSTR = (PQA008 + PQ006 + 2 * (TQA057)/4;

math involv. math part (inserv) principal role

CONFL = (PQA054 + PQA058 + TQA083 + TQA084)/4;

satis w/dec (P) confl. ident (P) sat. w/dec (T) confl. ident. (T)

FACE = (PQA053 + TQA082);

work well tog. (P) work well tog. (T)

(2) Agreement of Perceptions

ALEAD = [(PQA051 - TQA080) * ABS ( )];

AINSTR = [(PQA008 - TQA057) * ABS ( ) + (PQA006 - TQA057) * AB ( )];

ACONFL = [(PQA054 - TQA083) * ABS( ) + (PQA058 - TQA084) * ABS( )]/2;

AFACE = [(PQA053 - TQA082) * ABS ( )];